Wildland Fire Decision Support Tools

Numerous support tools for intelligence gathering and analyses are readily available to aid fire managers and administrators in making risk informed decisions. These tools help managers understand the big picture such as seasonal severity. They assist with predicting fire behavior outcomes such as probable fire size, day-to-day progression, fire intensity and severity. Outputs from the tools provide additional information to assist with the risk assessment, determining the best incident objectives and strategies and completing the decision rationale; all of which lead to a safe and effective courses of action.

The tools described below range from simple and quick tools that are informational or only require basic fire behavior knowledge to run, to more complex programs that demand a high level of technical expertise to input, run, calibrate and interpret.

Significant 7-Day Fire Potential – The 7 Day Fire Potential is provided by the Geographic Coordination Center's (GACC) Predictive Services. It is a daily analysis of fuel dryness and weather conditions indicative of significant fire growth (now available in WFDSS).

Zone Weather Forecast – Zone and spot weather forecasts are immediately available to decision makers to evaluate near-term weather.

Fire Behavior Observations – Responders on the fireline will have useful observations of current fire behavior and fuels conditions that should be considered in decision making.

Potential Fire Size – Fire history, which should be readily available to the unit given postseason assessments and preseason planning, may be useful in predicting where current fires may burn, the potential size, and possible fire effects. A comparison of the current fire season to others can be useful in determining relative potential.

Fire Effects Information System (FEIS) – A comprehensive database of annotated literature citations organized around individual plant and animal species.

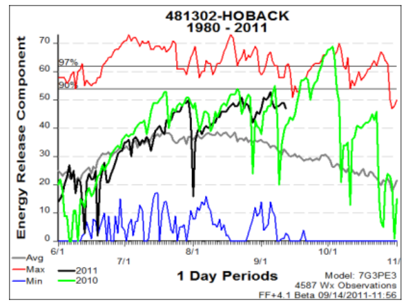
First Order Fire Effect Model (FOFEM) - A software program used to model plan mortality, fuel consumption, and smoke production.

BehavePlus/Nomagrams – A fire modeling system that is a collection of models that describes fire behavior, fire effects, and the fire environment. BEHAVE Plus is a non-spatial fire behavior modeling system that provides fire behavior projections for a single point source. These quick simulations can be used to assist ground-level tactical decisions such as line construction, safety zones, and point protection activities. They provide fire behavior information on: surface fire spread, crown fire, fire size, containment success, spotting distance, scorch height, tree mortality, and probability of ignition. Most of the same outputs are available from Nomagrams, which do not require a computer.

Fire Family Plus (***Fire Climatology and Occurrence Program)*** – The program combines fire climatology and occurrence analysis capabilities with a graphical user interface. It allows users to summarize and analyze weather observations, link weather with local historic fire occurrence data, and compute fire danger indices based on the National Fire Danger Rating System (NFDRS) and Canadian Forest Fire Danger Rating System (CFDRS). It can be used to compare raw weather inputs such as temperature, wind and precipitation and provides fire danger indices useful for strategic decision making.

National Fire Danger Rating System (NFDRS)/Weather Information Management System (WIMS) – WIMS is used to collect and process weather data and combine it with fuels, topography to produce National Fire Danger System indices. These indices provide indications of potential fires, including initiation, spread, and difficulty of control. NFDRS indices give managers a broad look at the type of fire season, and provide daily information on how ignitions may burn. It combines weather, climate, and fuels information to predict relative fire danger and provides daily fire danger indices and components enabling seasonal tracking of fire danger trends and periods of concern.

ERC Graphs – Found on local "Pocket Cards," this analysis can be updated annually and be readily available to compare the current season to previous years. FireFamilyPlus is used to display Energy Release Component (ERC), a common indicator of fire season severity. Example: This graph was created in early September and shows that 2011 was tracking similar to the 2010 fire season for this area. Indices were approaching the 90th percentile which indicates until a break in the weather occurred; fire behavior on new and existing starts will exhibit above average fire behavior for this time of year.



Term Graphs – A term graph can be created in FireFamilyPlus preseason, using local fire behavior expertise to define what type of weather parameters have typically caused a season ending event. (e.g. precipitation over a certain period of time). The graphs display waiting time probabilities of a season ending event.

Fuel Moisture Monitoring – Monitoring and tracking live and dead fuel moisture content provides daily, weekly, monthly, and seasonal tracking capabilities to support fire danger calculations and fire behavior predictions. It provides valuable information related to fire potential as a percentage for both dead and live fuels. Fuel moisture monitoring is limited by data quality. The frequency of sampling is of highest value when used in combination with fire danger indices and fire behavior predictions. Fuels sampling programs are invaluable in calibrating analysis and determining seasonal severity.

Cost Spreadsheet – A cost spreadsheet can be downloaded from WFDSS and contains estimated costs for teams, crews, equipment, aircraft, etc. It can be used to estimate potential costs.

I-Suite Cost Projection – The I-Suite application consists of Resources, Costs, Time, Incident Action Plans, and Supply Units supporting an incident. This information can be used as "real" time information for the management of an incident, or it can be used to help build a historical financial database for a specific unit.

SCI – Stratified Cost Index (SCI) - Developed as an interim performance measure for suppression expenditures, SCI provides an analysis of comparable fire suppression costs from historic data by geographic area and fuel type. The output matrix displays a quantifiable comparison of current expenditures with historic ranges,

Clarifying Questions

When considering which tool to use to support a risk informed decision, consider the following.

Are the decision support tool outputs needed to make a decision (use of these tools is not required), or has a decision essentially been made?

Is your question about values at risk or relative costs?

Do you want information for a specific time period such as "the next 24 hours" or "the next 14 days?"

How much time do you have before the product is needed?

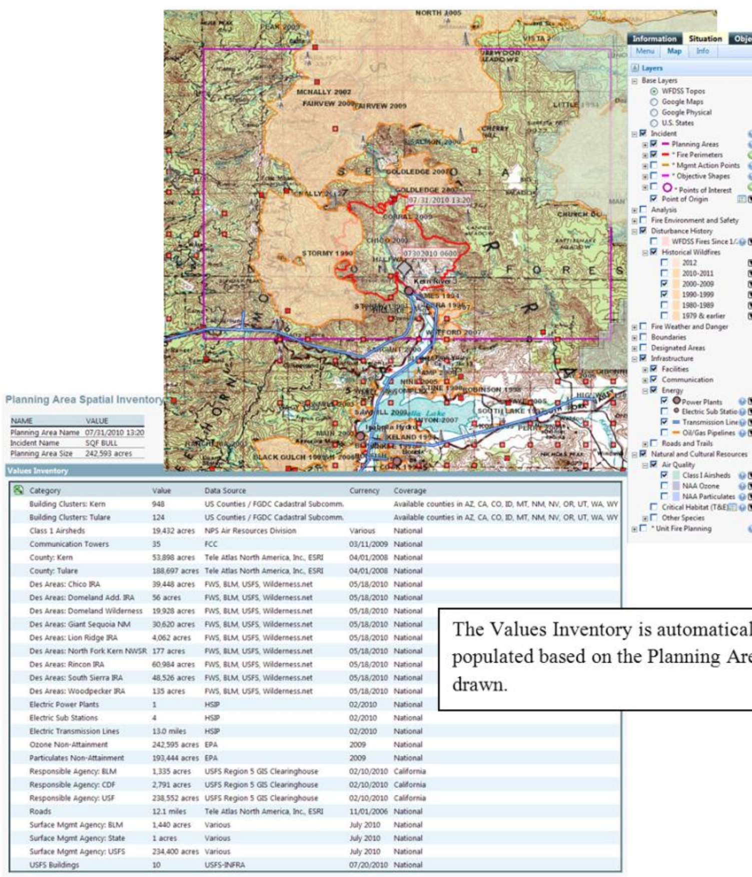
Wildland Fire Decision Support Tools

The SCI tool is based on historic suppression costs by fire size, location (inside or outside wilderness and distance to town), ERC percentile, fuel model, and the agency of jurisdiction. Users enter up to four potential final fire sizes. The result is a matrix of fire sizes and percentage of fires in comparison. The results are color coded - anything less than the 50th percentile is green, indicating near or below average costs. Yellow means costs are high and should be monitored and documented closely. Red means the costs are in the upper 10% for similar fires. See the WFDSS Help Topic Stratified Cost Index for information on Creating, Editing, and Accepting a Stratified Cost Index, and more, http://wfdss.usgs.gov/wfdss_help/index.htm

Acres Burned	25%	50%	75%	90%
19322	$226	$865	$3,317	$5,916
31840	$186	$715	$2,742	$4,891
59000	$147	$565	$2,167	$3,866
120000	$112	$431	$1,653	$2,949

Stratified Cost Index compares the current fire situation to similar fires and displays a table showing various acreages and associated costs of those fires. Here, 25% of similar fires that burned 19,322 acres or fewer had a cost of $226/acre or less, and 90% of those fires had costs of $5,916/acre or less.

WFDSS Spatial Values Inventory – The Values Inventory provides a table of values within a given area (a Planning Area or the fire projection path from either Short-Term or Near Term Fire Behavior). The table provides information on the value quantity (acres, miles, count, etc.), data source, currency, and coverage. Users can view a map display of the queried area from the Situation tab to help users visualize data geographically and it can be included as a map capture into the incident or decision content. There are numerous national and interagency geospatial values layers in WFDSS. Local data of interest can be loaded preseason as Unit Shapes so they will be identified in the inventory. WFDSS Values Inventory includes geospatial data such as Class I Airsheds and national infrastructure to quantify the values within the given area. It is intended as a strategic tool and is a fast method to see and quantify values within the fire planning or fire projection area. For more information see the WFDSS Help section on Obtaining a values Inventory http://wfdss.usgs.gov/wfdss_help/index.htm

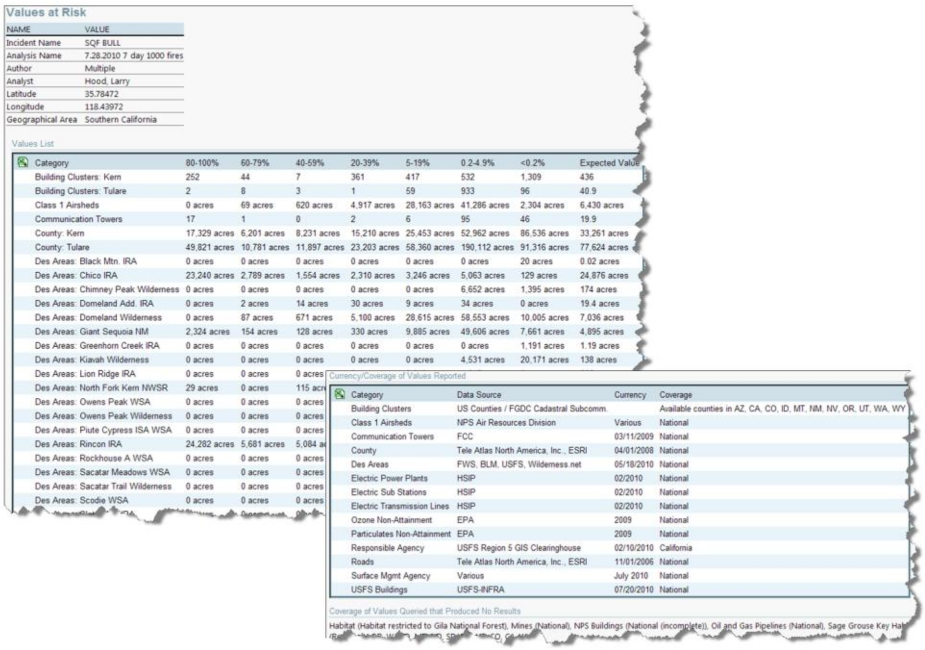


NAME	VALUE
Planning Area Name	07/31/2010 13:20
Incident Name	SQF BULL
Planning Area Size	242,593 acres

Category	Value	Data Source	Currency	Coverage
Building Clusters: Kern	948	US Counties / FGDC Cadastral Subcomm.		Available counties in AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY
Building Clusters: Tulare	124	US Counties / FGDC Cadastral Subcomm.		Available counties in AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY
Class 1 Airsheds	19,432 acres	NPS Air Resources Division	Various	National
Communication Towers	35	FCC	03/11/2009	National
County: Kern	53,898 acres	Tele Atlas North America, Inc., ESRI	04/01/2008	National
County: Tulare	188,697 acres	Tele Atlas North America, Inc., ESRI	04/01/2008	National
Des Areas: Chico IRA	39,448 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Domeland Add. IRA	56 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Domeland Wilderness	19,928 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Giant Sequoia NM	30,620 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Lion Ridge IRA	4,062 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: North Fork Kern NWSR	177 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Rincon IRA	60,984 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: South Sierra IRA	48,526 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Des Areas: Woodpecker IRA	135 acres	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Electric Power Plants	1	HSIP	02/2010	National
Electric Sub Stations	4	HSIP	02/2010	National
Electric Transmission Lines	13.0 miles	HSIP	02/2010	National
Ozone Non-Attainment	242,595 acres	EPA	2009	National
Particulates Non-Attainment	193,444 acres	EPA	2009	National
Responsible Agency: BLM	1,335 acres	USFS Region 5 GIS Clearinghouse	02/10/2010	California
Responsible Agency: CDF	2,791 acres	USFS Region 5 GIS Clearinghouse	02/10/2010	California
Responsible Agency: USF	238,552 acres	USFS Region 5 GIS Clearinghouse	02/10/2010	California
Roads	12.1 miles	Tele Atlas North America, Inc., ESRI	11/01/2006	National
Surface Mgmt Agency: BLM	1,440 acres	Various	July 2010	National
Surface Mgmt Agency: State	1 acres	Various	July 2010	National
Surface Mgmt Agency: USFS	234,400 acres	Various	July 2010	National
USFS Buildings	10	USFS-INFRA	07/20/2010	National

The Values Inventory is automatically populated based on the Planning Area drawn.

WFDSS Values at Risk – WFDSS Values at Risk (VAR) combines FSPro output with national and preloaded local value data to quantify the specific values within each probability contour (acres, miles, count, etc.). Similar to Values Inventory, VAR provides the values information in a table, and a map of the inventory area is available from the Situation map. The map capture feature can be used to add an image to the incident and decision content. Like Values Inventory, VAR is also intended as a strategic planning tool and provides a quick method to quantify values within an FSPro projection area. For more information, go to the WFDSS Help section Values at Risk Information, http://wfdss.usgs.gov/wfdss_help/index.htm



Values at Risk

NAME	VALUE
Incident Name	SQF BULL
Analysis Name	7.28.2010 7 day 1000 fires
Author	Multiple
Analyst	Hood, Larry
Latitude	35.78472
Longitude	118.43972
Geographical Area	Southern California

Values List

Category	80-100%	60-79%	40-59%	20-39%	5-19%	0.2-4.9%	<0.2%	Expected Value
Building Clusters: Kern	252	44	7	361	417	532	1,309	436
Building Clusters: Tulare	2	8	3	1	59	933	96	40.9
Class 1 Airsheds	0 acres	69 acres	620 acres	4,917 acres	28,163 acres	41,286 acres	2,304 acres	6,430 acres
Communication Towers	17	1	0	2	6	95	46	19.9
County: Kern	17,329 acres	6,201 acres	8,231 acres	15,210 acres	25,453 acres	52,962 acres	86,536 acres	33,261 acres
County: Tulare	49,821 acres	10,781 acres	11,897 acres	23,203 acres	58,360 acres	190,112 acres	91,316 acres	77,624 acres
Des Areas: Black Mtn. IRA	0 acres	0 acres	0 acres	0 acres	0 acres	0 acres	20 acres	0.02 acres
Des Areas: Chico IRA	23,240 acres	2,789 acres	1,554 acres	2,310 acres	3,246 acres	5,063 acres	129 acres	24,876 acres
Des Areas: Chimney Peak Wilderness	0 acres	0 acres	0 acres	0 acres	0 acres	6,652 acres	1,395 acres	174 acres
Des Areas: Domeland Add. IRA	0 acres	2 acres	14 acres	30 acres	9 acres	34 acres	0 acres	19.4 acres
Des Areas: Domeland Wilderness	0 acres	87 acres	671 acres	5,100 acres	28,615 acres	58,553 acres	10,005 acres	7,036 acres
Des Areas: Giant Sequoia NM	2,324 acres	154 acres	128 acres	330 acres	9,885 acres	49,606 acres	7,661 acres	4,895 acres
Des Areas: Greenhorn Creek IRA	0 acres	0 acres	0 acres	0 acres	0 acres	0 acres	1,191 acres	1.19 acres
Des Areas: Kiavah Wilderness	0 acres	0 acres	0 acres	0 acres	0 acres	4,531 acres	20,171 acres	138 acres
Des Areas: Lion Ridge IRA	0 acres	0 acres	0 acres					
Des Areas: North Fork Kern NWSR	29 acres	0 acres	115 acr					
Des Areas: Owens Peak WSA	0 acres	0 acres	0 acres					
Des Areas: Owens Peak Wilderness	0 acres	0 acres	0 acres					
Des Areas: Piute Cypress ISA WSA	0 acres	0 acres	0 acres					
Des Areas: Rincon IRA	24,282 acres	5,681 acres	5,084 a					
Des Areas: Rockhouse A WSA	0 acres	0 acres	0 acres					
Des Areas: Sacatar Meadows WSA	0 acres	0 acres	0 acres					
Des Areas: Sacatar Trail Wilderness	0 acres	0 acres	0 acres					
Des Areas: Scodie WSA	0 acres	0 acres	0 acres					

Currency/Coverage of Values Reported

Category	Data Source	Currency	Coverage
Building Clusters	US Counties / FGDC Cadastral Subcomm.		Available counties in AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY
Class 1 Airsheds	NPS Air Resources Division	Various	National
Communication Towers	FCC	03/11/2009	National
County	Tele Atlas North America, Inc., ESRI	04/01/2008	National
Des Areas	FWS, BLM, USFS, Wilderness.net	05/18/2010	National
Electric Power Plants	HSIP	02/2010	National
Electric Sub Stations	HSIP	02/2010	National
Electric Transmission Lines	HSIP	02/2010	National
Ozone Non-Attainment	EPA	2009	National
Particulates Non-Attainment	EPA	2009	National
Responsible Agency	USFS Region 5 GIS Clearinghouse	02/10/2010	California
Roads	Tele Atlas North America, Inc., ESRI	11/01/2006	National
Surface Mgmt Agency	Various	July 2010	National
USFS Buildings	USFS-INFRA	07/20/2010	National

Coverage of Values Queried that Produced No Results

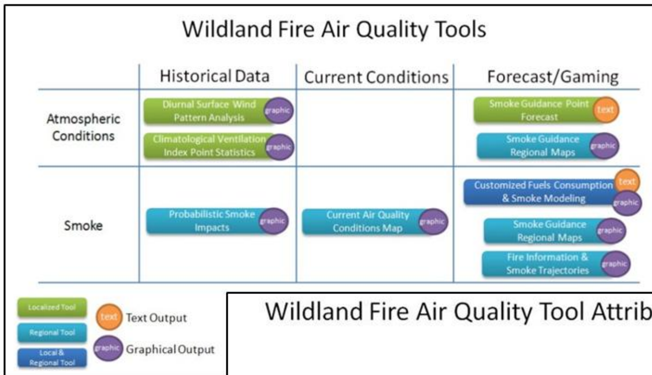
Habitat (Habitat restricted to Gila National Forest), Mines (National), NPS Buildings (National (incomplete)), Oil and Gas Pipelines (National), Sage Grouse Key Ha

Comparison of the three WFDSS Economic Tools

Tools	Values Inventory (VI)	Values at Risk (VAR)	Stratified Cost Index (SCI)
Time Period of Interest (must be same as analysis period)	1 – 3 days	Next 7 – 30 days	Immediate and cumulative
Time Needed to Complete Analysis	Less than one minute upon completion of STFB and NTFB, immediate upon drawing planning area	Completed with FSPro simulation	A few minutes
Analysis Type	Automated	Automated	Manual
What are the Values at Risk near this fire?	Lists the number of values by specific type within a planning area or STFB/NTFB Arrival Time footprint.	Lists the number of values by specific type and their probability of being affected by fire.	
How do costs on this fire compare to similar fires?			SCI is a table that compares costs of similar fires based on jurisdiction fuel model at point of ignition, and fire size.
What values are in the predicted fire movement over the next day or two?	X		
What is the probability and count of values being affected in the next week or two?		X	
Most values in FMUs are included. Primarily values related to land management agencies	X	X	
Buildings on federal land	X	X	
Local values data preloaded as Unit Shapes in the fire's vicinity such as species of concern, no dipping areas, specific habitat etc.			
Partial county building cluster data	X	X	

Air Quality Tools

The USDA Forest Service, Pacific Northwest AirFire Team hosts the Wildland Fire Air Quality Tools site. The tools can be used to assess past, current, and potential smoke and atmospheric conditions on wildland fires. The images below display the different tool attributes found at: http://firesmoke.us/wfdss/



Wildland Fire Air Quality Tool Attributes

		Instant Access	Easy to Use	Localized	Regional	Textual	Graphical	Interactive	Smoke	Atmospheric Conditions
Historical Data	Diurnal Surface Wind Pattern Analysis	X	X	X			X			X
	Climatological Ventilation Index Point Stats	X		X			X			X
	Probabilistic Smoke Impacts based on Past Weather				X		X		X	
Current Condition	Current Air Quality Conditions Map	X	X		X		X		X	
Forecast/Gaming	Smoke Guidance Point Forecast	X	X	X		X				X
	Fire Information & Smoke Trajectories	X	X		X		X	X	X	
	Customized Fuels, Consumption, & Smoke Modeling	X	X	X	X	X	X	X	X	
	Smoke Guidance Regional Maps	X	X		X		X		X	X

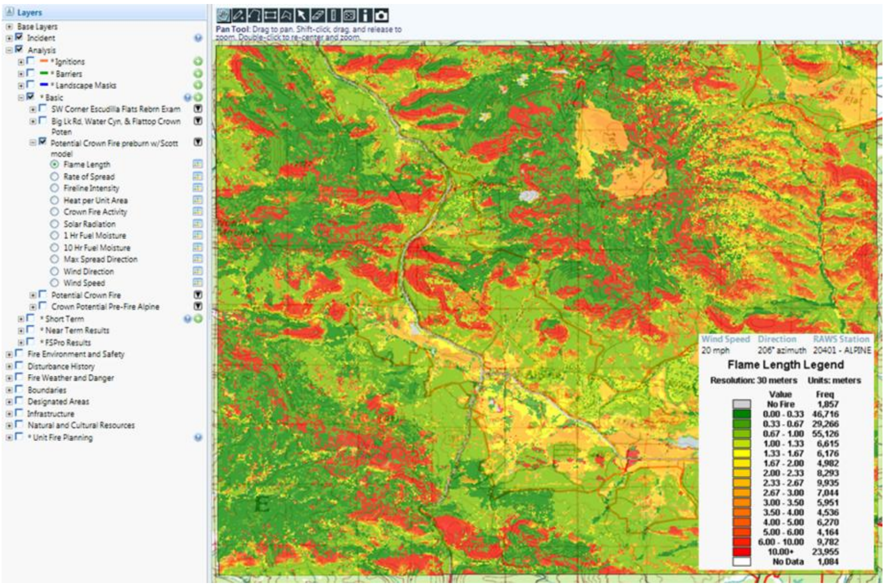
Geospatial Fire Behavior Tools

Geospatial fire behavior tools simulate fire behavior characteristics over a landscape rather than a single point. This chart summarizes key differences between some of the different geospatial tools.

Spatial Fire Behavior Tools

Tools	Basic Fire Behavior (BFB)	FlamMap	Short-Term Fire Behavior (**STFB**)	FARSITE	Near-Term Fire Behavior (**NTFB**)	Fire Spread Probability (**FSPro**)
"Spread Model"	FlamMap Grid	Minimum Travel Time (MTT) (Finney 2002)	Minimum Travel Time (MTT) (Finney 2012) **STFB and FSPRO are being continually updated to match FlamMap 5 beta**	FARSITE (Finney 1998)	FARSITE (Finney 1998) **NTFB is slowly becoming its own unique thing. It has evolved considerably from FARSITE**	Minimum Travel Time (MTT) (Finney 2012) **STFB and FSPRO are being continually updated to match FlamMap 5 beta**
Duration	"Snapshot in time"	1 to 3 days	1 to 3 days	1 to 7 days	1 to 7 days	7 to 30 days
Weather	Daily, constant weather, wind, & fuel moisture	Daily, constant weather, wind, & fuel moisture	Daily, constant weather, wind, & fuel moisture	Hourly, variable weather, wind, & fuel moisture	Hourly, variable weather, wind, & fuel moisture	Hourly, variable weather, wind, & fuel moisture-plus ERC seasonal trend, auto-correlation, standard deviations & artificial time series
Type of Tool	Only in WFDSS	PC desktop	Only in WFDSS	PC desktop	Only in WFDSS	Only in WFDSS
Data Source	Automatic upload/editable LANDFIRE and NDFD	Manual Creation of LCP, Fuel Moisture & Weather files	Automatic upload/editable LANDFIRE and NDFD	Manual Creation of LCP, Fuel Moisture & Weather files	Automatic upload/editable LANDFIRE and NDFD	Automatic upload/editable LANDFIRE and NDFD
Output	Raster display of fire behavior	Major flow paths; arrival times	Major flow paths; arrival times	Perimeter; fire behavior grids	Perimeter; fire behavior grids	Probability surface

<u>WFDSS Basic Fire Behavior (FlamMap)</u> – Basic Fire Behavior (BFB) can be described as “Spatial Behave Plus.” It computes similar fire behavior calculations for all the points on a landscape. There is a simplified version of the tool called Automated Basic Fire Behavior in which limited editing of inputs is allowed, providing quick course outputs. Outputs include flame length, rate of spread, crown fire activity, and fire line intensity. Basic Fire Behavior does not address the probability of the cell burning; it only provides fire behavior outputs that would occur on the landscape if it had burned under the specified conditions.



BFB inputs are static, one wind, fuel moisture etc. In this example, “flame length” is selected. The red ignition points can be seen and under the current weather conditions, the area in the general vicinity of the start will burn with primarily 1- to 3-foot flame lengths. Where the brighter colored areas to the southeast exist higher intensities are expected. Note the other “basic results” that can be displayed from the left hand column.

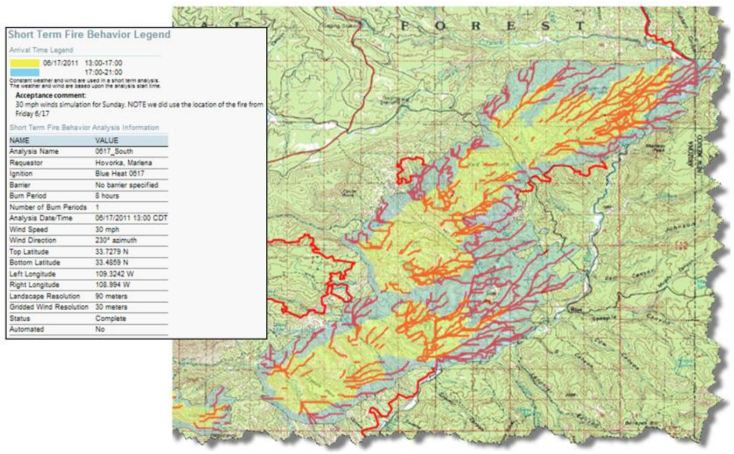
Basic Fire Behavior (BFB) Assumptions & Limitations

1. WFDSS Basic Fire Behavior (BFB) calculates fire behavior outputs using fuel moistures based on topographic information, forest canopy cover, and the previous days of weather data (for fuel moisture conditioning) from the selected RAWS, as well as National Digital Forecast Data (NDFD) forecasted weather and wind data. Weather data from the RAWS and the forecast data need to be critiqued and, potentially, adjusted by the analyst.
2. Fire behavior calculations are performed independently for each cell on the landscape
3. BFB uses the same underlying fire models (Rothermel's 1972 surface fire model, Van Wagner's 1977 crown fire initiation model, Rothermel's 1991 crown fire spread model, and Nelson's 2000 dead fuel moisture model) used in other fire behavior applications. Thus, the assumptions and limitations of those underlying fire models are inherent within BFB.
4. As with all models, the quality of the outputs depends on the quality of the inputs. If the landscape data, RAWS data, or forecast data used are inadequate, the resulting fire behavior outputs will be questionable. It is important to critique and modify as needed, the fuels data, as well as the RAWS and forecast data before using BFB in support of wildland fire decision-making.

Wildland Fire Decision Support Tools

<u>WFDSS Short Term Fire Behavior</u>- Short-Term Fire Behavior (STFB) provides the same outputs as Basic Fire Behavior with the addition of a fire spread projection using the Minimum Travel Time (MTT) fire growth algorithm. MTT searches for the set of pathways with minimum spread times from a point, line, or polygon ignition source, keeping fuel moistures and wind conditions constant for the duration of the simulation. Because of the input constraints, STFB is best limited to predictions for one burn period or burn periods in which conditions are static. Like Basic Fire Behavior, Short Term Fire Behavior has a simplified version of the tool called Automated Short Term Fire Behavior in which limited editing of inputs is allowed, providing quick course outputs. Short Term projections do not consider diurnal fluctuations in winds and fuels moistures.

> **Clarifying Questions**
>
> Where is the fire expected to be at the end of the burn period?
>
> What are the possible major fire paths?



Short Term Fire Behavior is used in this example to show the fire's predicted growth over an 8 hour burn period. The red lines indicate Minimum Travel Time (MTT) paths. The colors show expected progression over the 4-hour burn period. STFB includes backing and flanking projections. It will also project what type of fire behavior is expected.

Short-Term Fire Behavior (STFB) Assumptions & Limitations

1. WFDSS Short-Term Fire Behavior (STFB) calculates fire spread and fire behavior outputs using fuel moistures based on topographic information, forest canopy cover, and the previous days of weather data (for fuel moisture conditioning) from the selected RAWS, as well as National Digital Forecast Data (NDFD) forecasted weather and wind data. Weather data from the RAWS and the forecast data need to be critiqued and potentially adjusted by the Fire Behavior Specialist (FBS).
2. Even though STFB can simulate many hours of fire spread, wind speed and direction are held constant for the duration of the simulation.
3. Fuel moisture values (as calculated at the analysis start date and time) are held constant for the duration of the STFB simulation.
4. WFDSS STFB uses most of the same underlying fire models (Rothermel's 1972 surface fire model, Van Wagner's 1977 crown fire initiation model, Rothermel's 1991 crown fire spread model, Albini's 1979 spotting from torching trees, and Nelson's 2000 dead fuel moisture model) used in other fire behavior applications. Thus, the assumptions and limitations of those underlying fire models are inherent within WFDSS STFB.
5. Fire growth calculations for STFB across the landscape extent are performed assuming independence of fire behavior between neighboring cells. In other words, the travel time across a cell does not depend on the behavior in adjacent cells.
6. As with all models, the quality of the outputs depends on the quality of the inputs. If the landscape data, RAWS data, or forecast data used are inadequate, the resulting fire behavior outputs will be

questionable. It is important to critique and modify as needed, the fuels data, as well as the RAWS and forecast data before using STFB results in support of wildland fire decision-making.

FARSITE – A desktop two-dimensional fire growth simulation model that computes fire behavior and spread over a range of time under conditions of heterogeneous terrain, fuels, and weather. It incorporates the existing models for surface fire, crown fire, spotting, postfrontal combustion, and fire acceleration into a two-dimensional fire growth model.

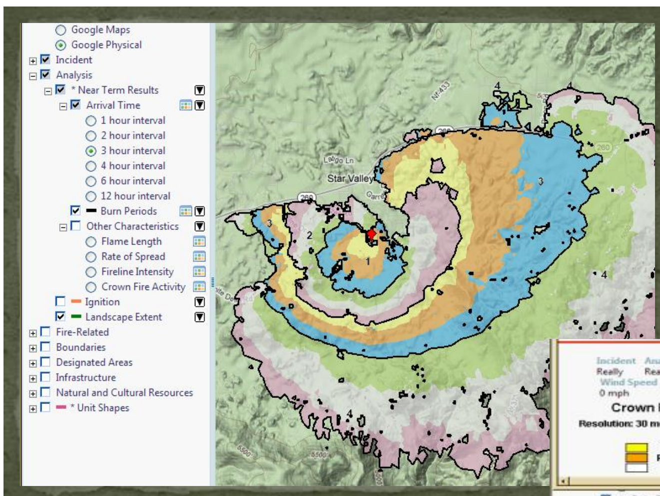
WFDSS Near-Term Fire Behavior *(based on FARSITE)* – Near Term Fire Behavior (NTFB) models fire growth in the form of a fire progression. Unlike Short-Term Fire Behavior, NTFB models fire behavior using inputs for weather and wind that change over the duration of the simulation. NTFB can model fire growth for up to 7 days, however caution should be used when projecting beyond reliable weather forecast timeframes. Near Term Fire Behavior simulates where and when a fire may grow, and also predicts fire behavior characteristics on the landscape where it does burn. In this example of NTFB output below each color represents a 3-hour interval; the black lines represent daily burn periods.

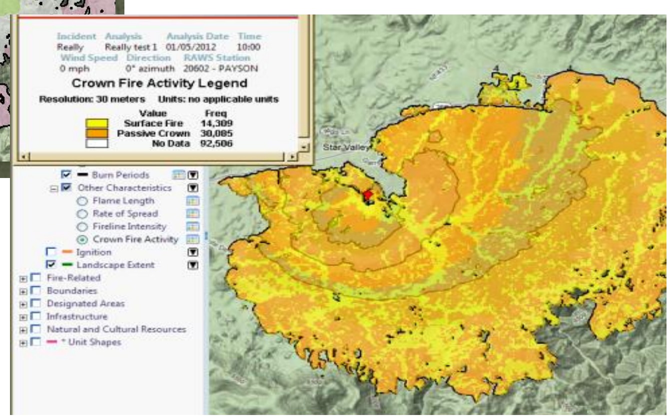
Clarifying Questions

Where is the fire expected to be at the end of each of the next four burn periods?

What fire behavior is expected during these burn periods?

When is the fire expected to reach a point of interest?





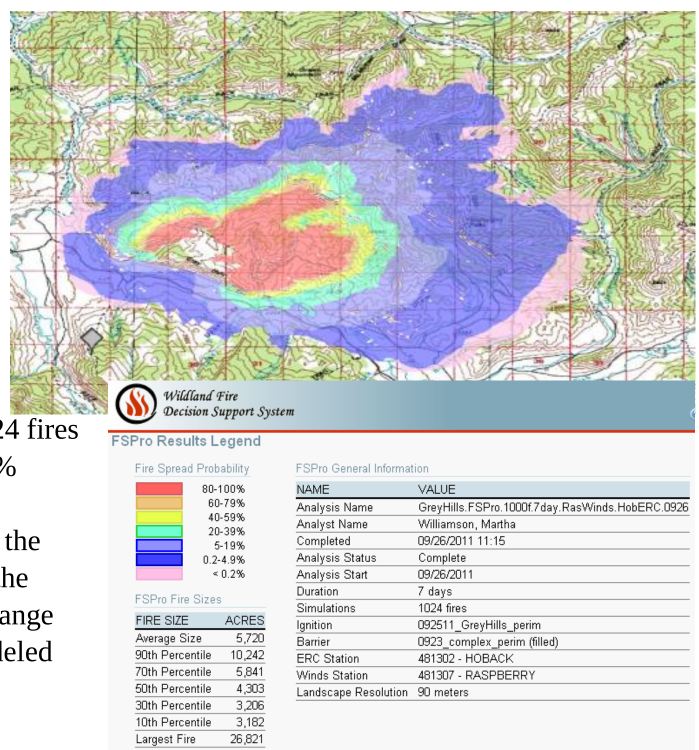
Near Term Fire Behavior (NTFB) Assumptions & Limitations

1. Weather is difficult to predict; fire forecasts are only as good as the input data. Use caution when running NTFB beyond a reliable forecast period. It becomes more probable that the actual weather may not match the forecast data the farther out in time an analysis is run. Weather data from the RAWS and the forecast data need to be critiqued and potentially adjusted by the Fire Behavior Specialist (FBS).
2. NTFB incorporates existing models for surface fire, spotting, postfrontal combustion and fire acceleration (among others), and all of the limitations and assumptions of those models are present. Many of these models are a part of the desktop program, BEHAVE, which is commonly described as having a range that can under predict by half or over predict by double.
3. When using the Scott and Burgan (2005) 40 fuel models, mistakes or incorrect assumptions with live fuel moisture transfer can result in faulty model outputs.

4. Fires are assumed to burn as ellipses under uniform conditions. This assumption allows the model to make a close approximation of fire growth, however, real conditions are clearly more complex and heterogeneous than any fire model.
5. Multiple fires and fire behavior calculated at vertices are assumed to burn independently of each other (there is no interaction between fire fronts).
6. Fire growth predictions tend to worsen over time because errors begin to compound.
7. Spotting from torching trees will likely under-predict spotting from active crown fire, particularly in relation to distance.
8. NTFB cannot assume the impacts (success or failure) of active suppression actions that are being undertaken. Analysts can add barriers to represent fireline or a cold fire perimeter, but cannot incorporate the impacts of aerial retardant or water, blacklining, burnouts or “stalling” actions. Alternatively, modeled fire that was not able to cross a barrier in NTFB will not subsequently smolder or creep across it at a later time as live fire can under real world conditions.
9. As with all models, the quality of the outputs depends on the quality of the inputs. If the landscape data, RAWS data, or forecast data used are inadequate, the resulting fire behavior outputs will be questionable. It is important to critique and modify as needed, the fuels data, as well as the RAWS and forecast data before using WFDSS NTFB results in support of wildland fire decision-making.

WFDSS Fire Spread Probability (FSPro) –FSPro is a geospatial probabilistic model that predicts fire growth, and is designed to support long-term decision-making (more than 5 days). FSPro addresses fire growth beyond the timeframes of reliable weather forecasts by using historic climatological data. FSPro calculates and maps the probability that fire will visit each pixel on the landscape of interest during the specified period of time, in the absence of suppression, based on the current fire perimeter or ignition point

The results do not predict actual fire perimeters, but instead show the probability that each cell will burn. Based on the historical data FSPro produces many weather scenarios for the selected time period. Each weather scenario is used to model an individual fire, (normally 1,000 to 4,000 fires), that are overlaid to produce a map with the probabilities. The FSPro output map produced is often misinterpreted as a perimeter map.



In this example below, FSPro simulated 1,024 fires for 7 days. The red area represents a 80-100% probability of being burned. The orange are represents 60-79%, the yellow area 40-59%, the green area 20-39%, the light purple 5-19%, the dark purple .2-4.9%, and the pink < .2 % change of burning in the 7 day period under the modeled conditions.

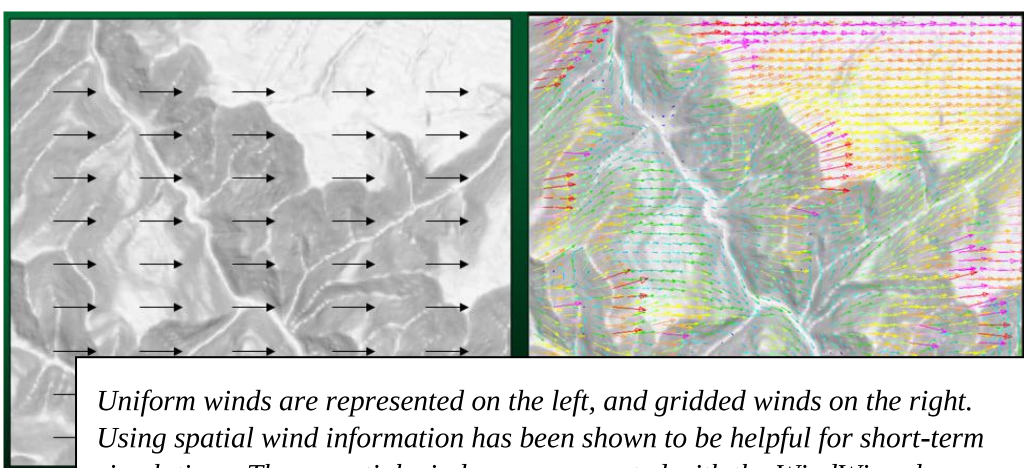
Fire Spread Probability (FSPro) Assumptions and Limitations

> **Clarifying Questions**
>
> What is the probability that the fire will reach a point of concern in the next 3 weeks?

Like all model systems, FSPro has numerous assumptions and limitations specific to each model it uses. It is important to be familiar with these when viewing model results. FSPro uses the same underlying fire models as BehavePlus, FARSITE, and FlamMap. The assumptions and limitations of those models are also inherent in FSPro (e.g., uniform fuels, etc.). Some additional assumptions and limitations of FSPro include the following:

1. FSPro results assume no suppression action (other than the inclusion of barriers to simulate effective fireline construction).
2. Limited fine-scale temporal variability in weather. This means that the weather is constant for the entire day (1 ERC value and related fuel moistures, 1 wind speed and wind direction).
3. The peak burning period is assumed because the ERC, fuel moisture, and wind are obtained at that time.
4. There is no correction of fuel moisture for elevation or aspect (forthcoming).
5. The FSPro model uses 100% for foliar moisture content. This value cannot be edited.
6. Winds and fuel moistures are independent.
7. No climate change prediction is available (assumes historic climate).
8. The extremely rare event may or may not be represented by the simulation.
9. The resulting burn probability maps are easily misinterpreted as a fire progression, such as in FARSITE (FSPro results show probability contours NOT daily progression perimeters!).
10. Model output is contingent on model input and modeler expertise. FSPro can only be as accurate as the data used as inputs to the model.

WindWizard- Gridded Wind Model – Produces gridded wind data that can be used for visualization, or visual display and review; and input to fire prediction models and is a method to provide information about the effect of topography on local wind flow. Wind information at this detail is not available from the weather service. The shape files produced can be used for review of the channeling and checking effects of local topography on wind flow – useful for operational, planning and educational purposes. The high resolution wind information is useful in identifying areas and/or conditions that may produce high fire intensity and spread rates and for identifying locations where fire spotting might occur.



Uniform winds are represented on the left, and gridded winds on the right. Using spatial wind information has been shown to be helpful for short-term simulations. These spatial winds were generated with the WindWizard program.